

~ Case Presentation & 5-Slides Focus Review~

# Mechanism of In-Stent Restenosis

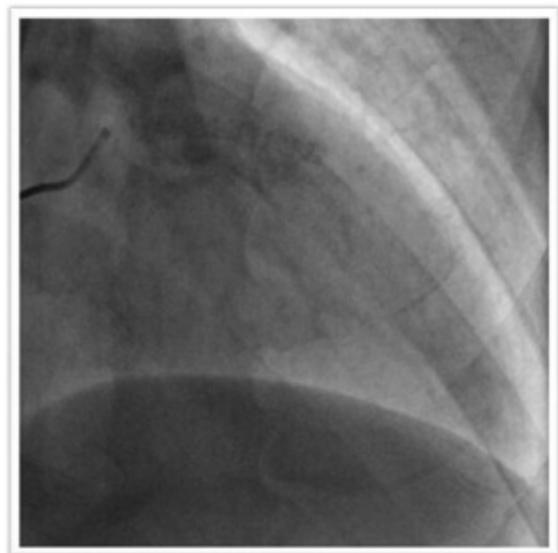


Seung-Ho Hur, MD, PhD, FACC

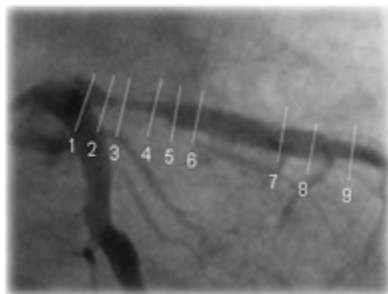
Keimyung University Dongsan Medical Center

# Case 1

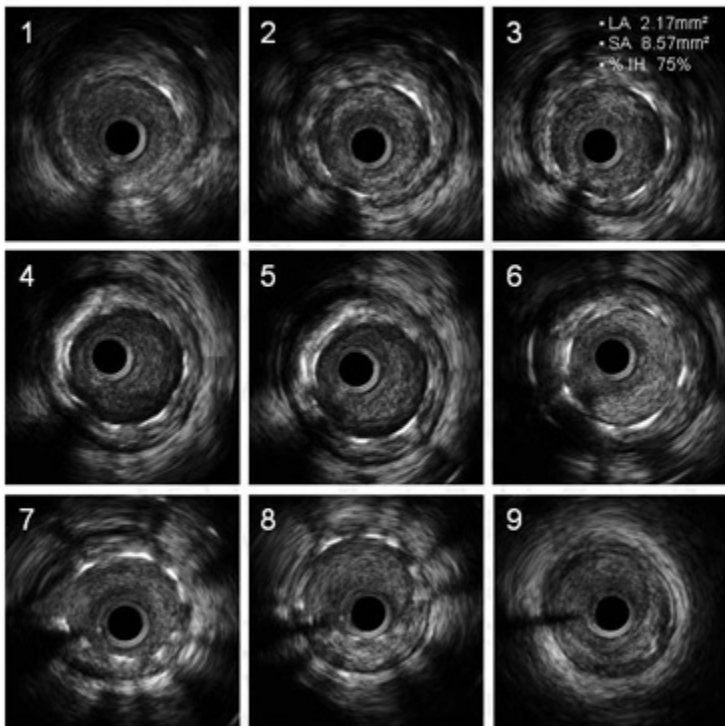
- 61YO / Male
- Unstable Angina
- T2DM, Smoking (+)
- 2Y ago: SES (3.5x28mm) dt NSTEMI
- DES ISR Type IC



# Pre-PCI IVUS Findings

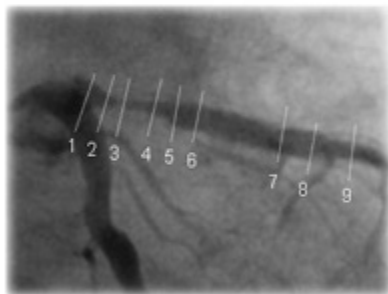


proximal ←

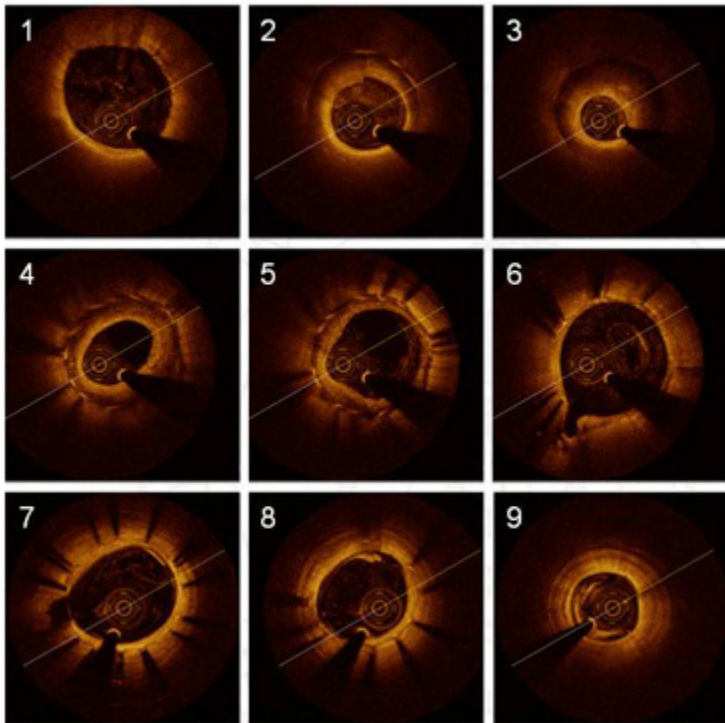


→ distal

# Pre-PCI OCT Findings

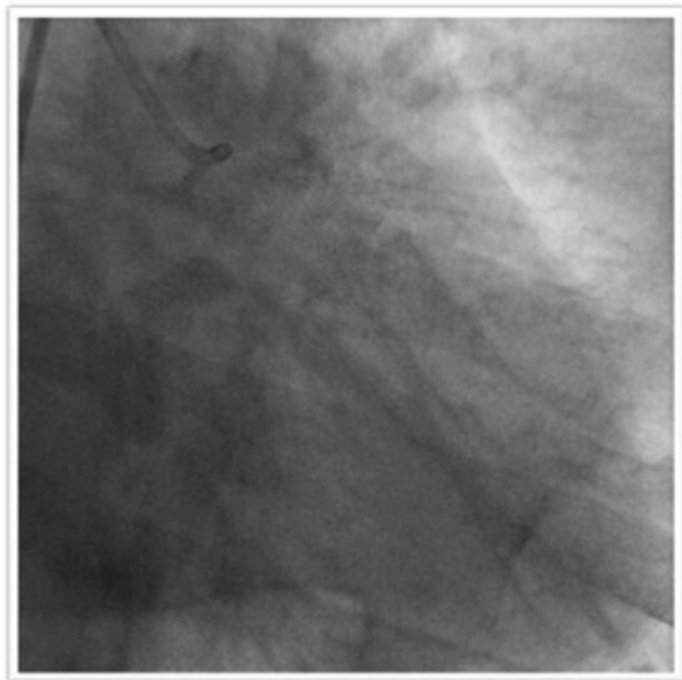
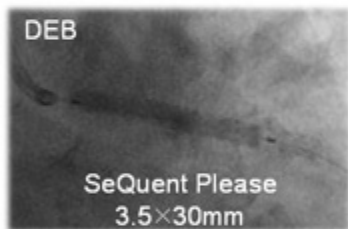
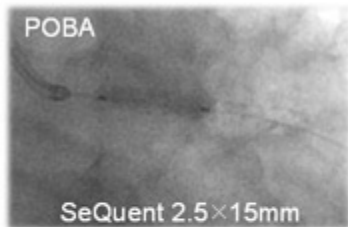


proximal ←



→ distal

# PCI for DES ISR

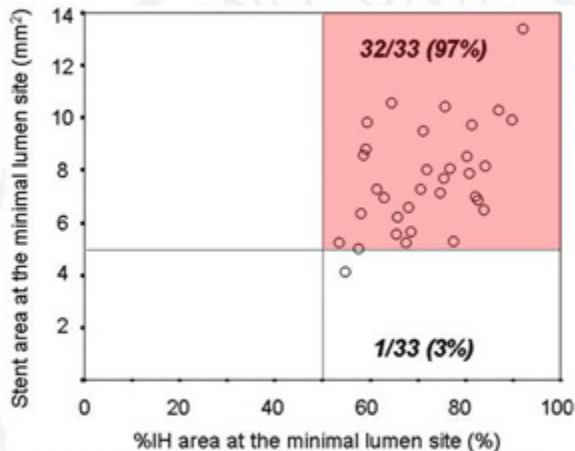
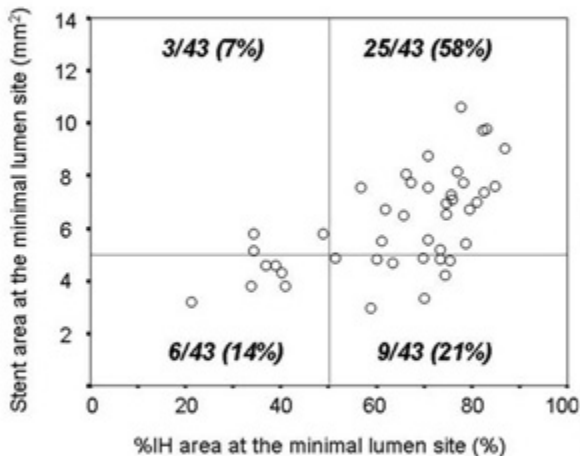


Final CAG

# Mechanisms of ISR after DES Implantation

47 lesions with total stent length >28 mm

33 lesions with total stent length ≤28 mm



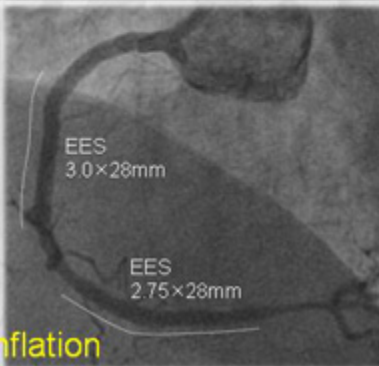
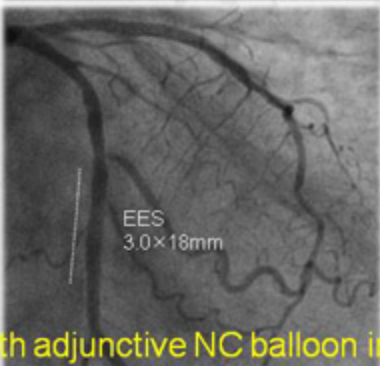
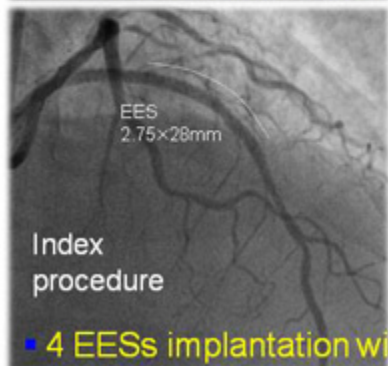
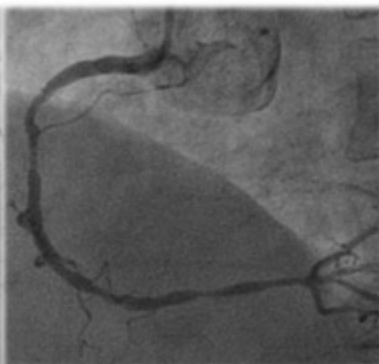
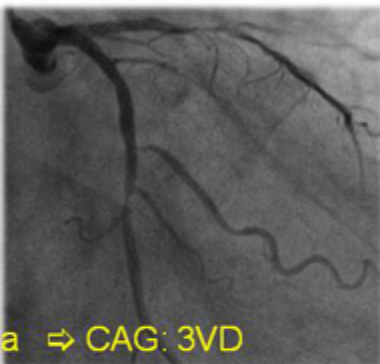
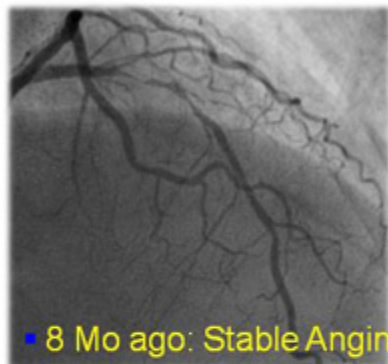
- In most DES restenosis, **intimal hyperplasia** was the dominant mechanism of ISR.
- Nevertheless, underexpansion associated with longer stent length remained an important preventable mechanism of ISR.

## Case II

■ 71YO / Female

■ NSTEMI

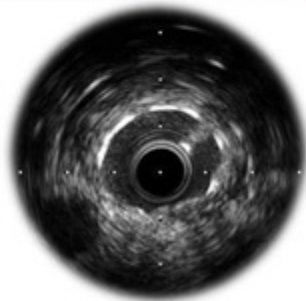
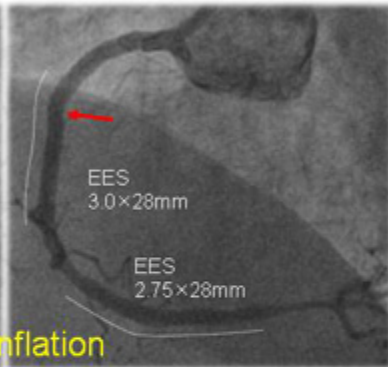
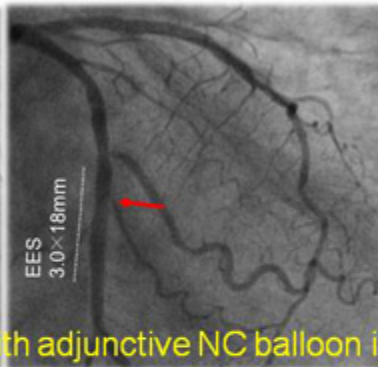
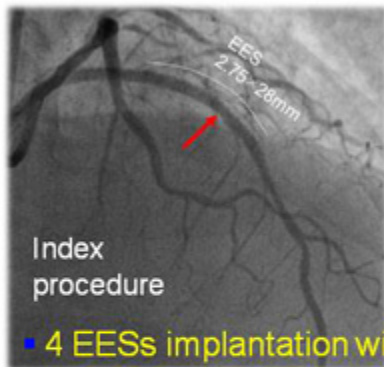
■ T2DM, HTN



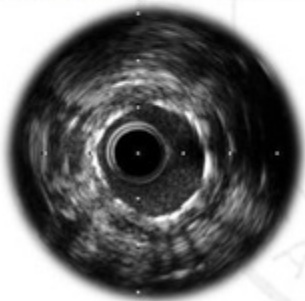
■ 4 EESs implantation with adjunctive NC balloon inflation

# MSA after Stenting in Each Vessel

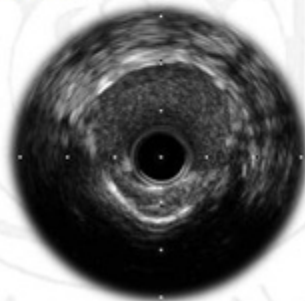
~ 8 Months ago ~



MSA 4.14mm<sup>2</sup>



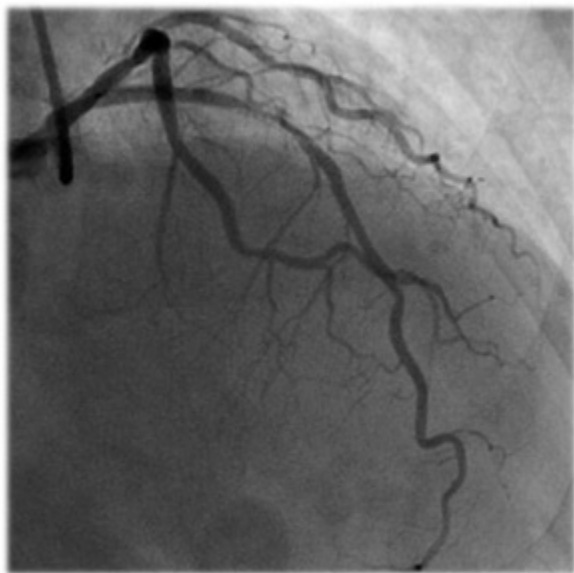
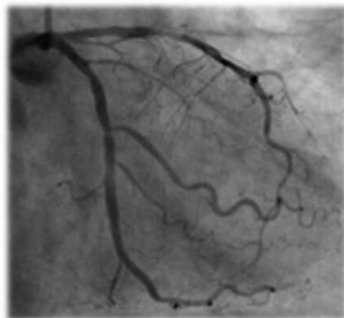
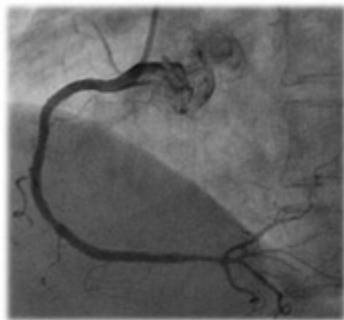
MSA 4.16mm<sup>2</sup>



MSA 5.51mm<sup>2</sup>

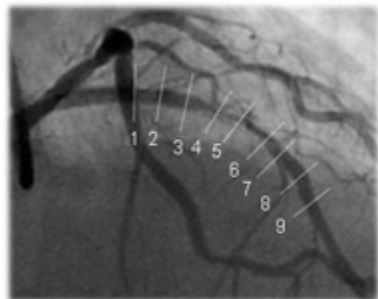


# ACS Presentation @ 8M FU

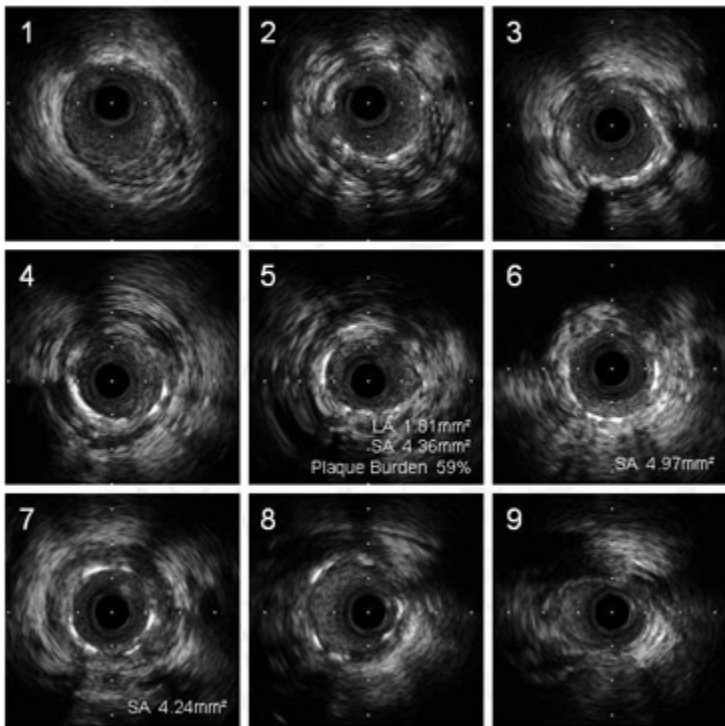


- DES ISR Type II

# IVUS Pullback

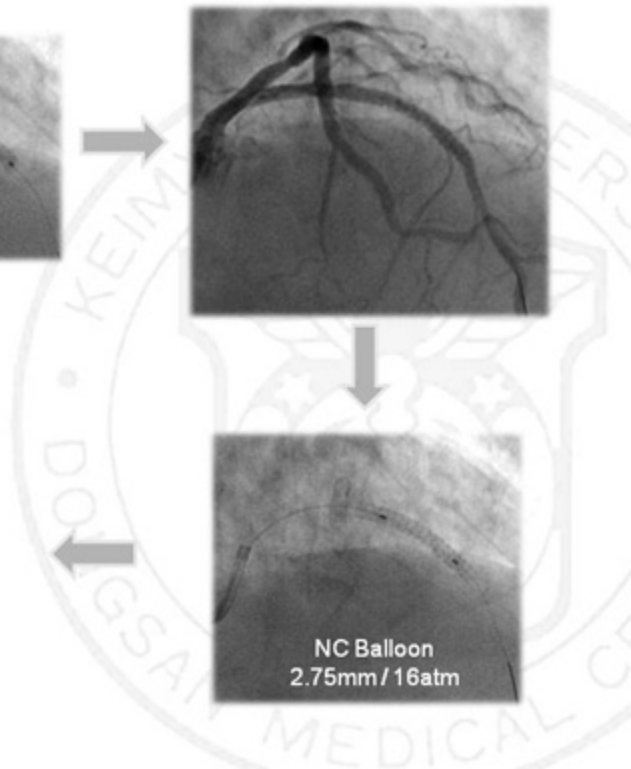
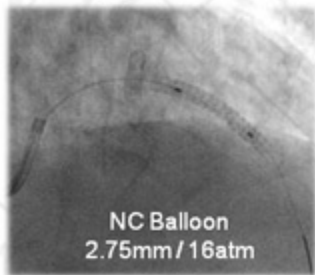
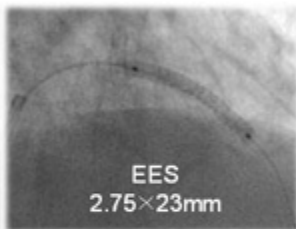
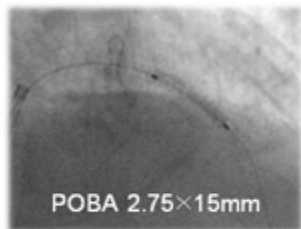


proximal ←



→ distal

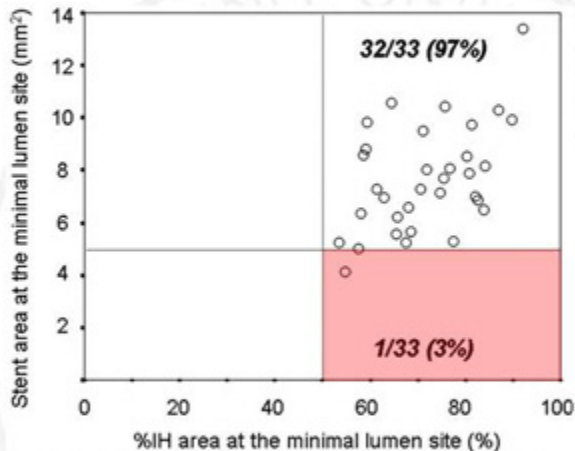
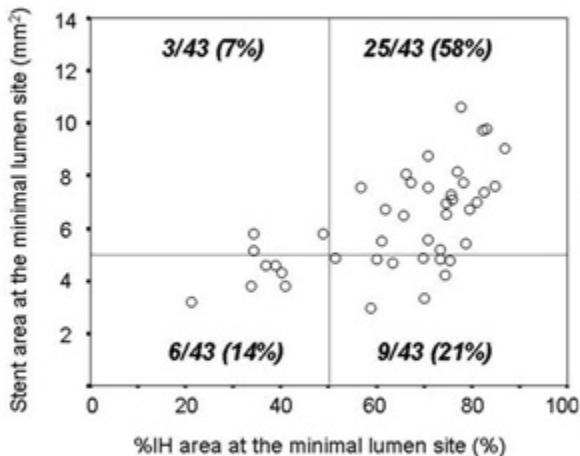
# PCI for DES ISR



# Mechanisms of ISR after DES Implantation

47 lesions with total stent length >28 mm

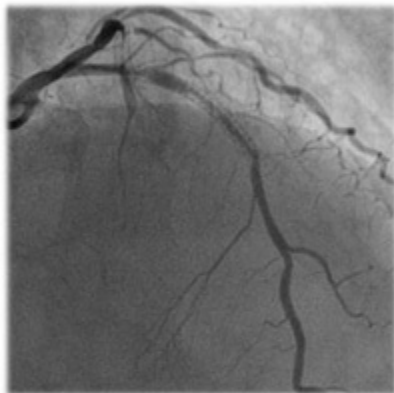
33 lesions with total stent length ≤28 mm



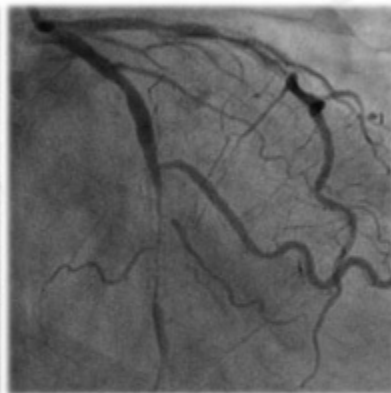
- In most DES restenosis, **intimal hyperplasia** was the dominant mechanism of ISR.
- Nevertheless, underexpansion associated with longer stent length remained an important preventable mechanism of ISR.

## 2<sup>nd</sup> ACS Presentation @ 6M FU

~ 14M after index procedure ~



▪ DES ISR Type II



▪ DES ISR Type III



▪ DES ISR Type II

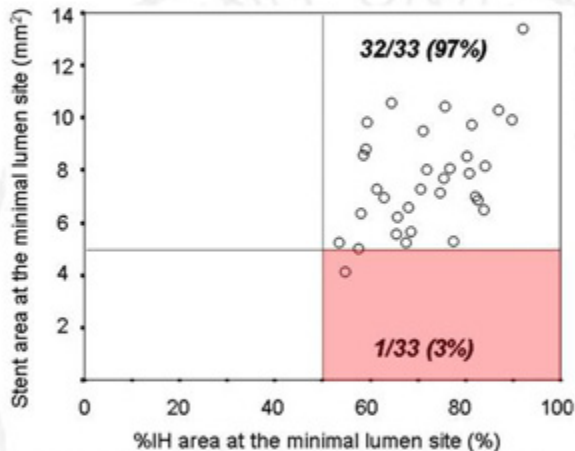
# Mechanisms of ISR after DES Implantation

- Technical factor
  - stent underexpansion



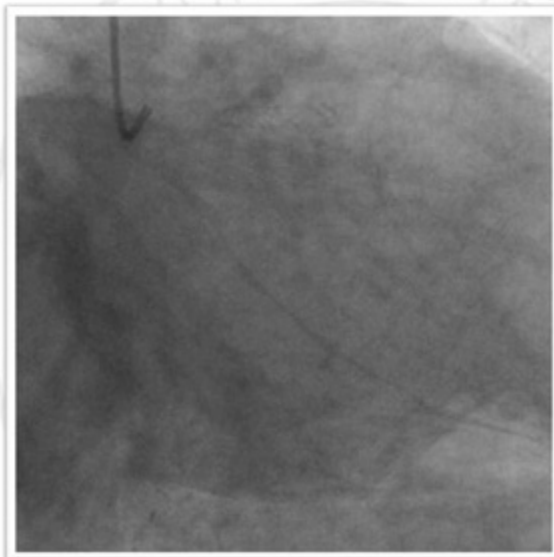
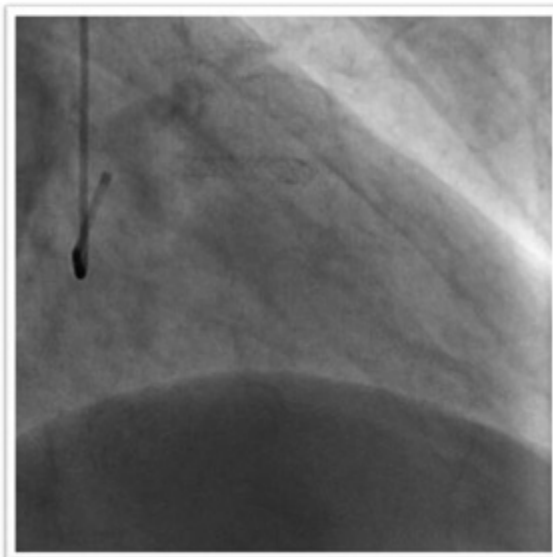
- Biologic factors
  - Intimal hyperplasia
  - hypersensitivity
  - drug resistance

33 lesions with total stent length  $\leq 28$  mm

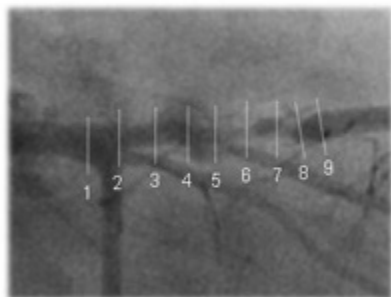


## Case III

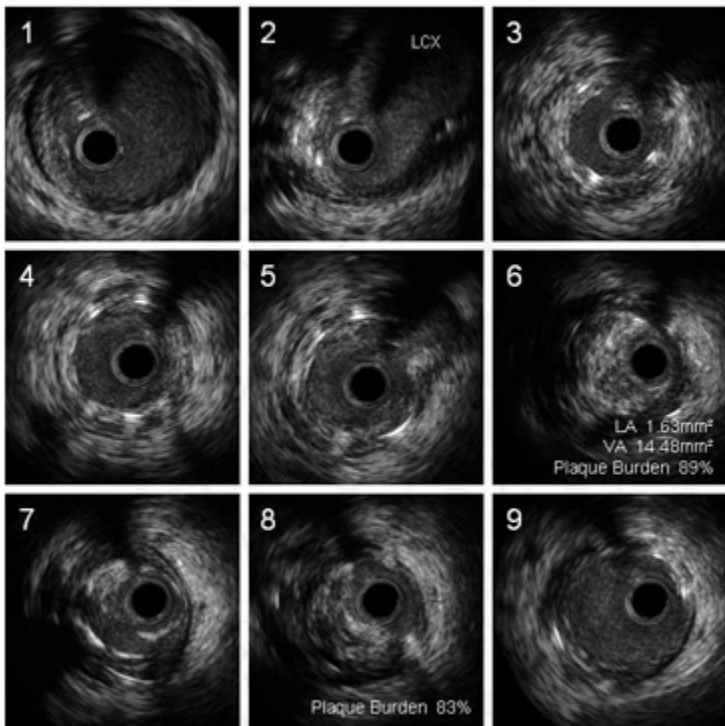
- 68YO / Male
- Unstable Angina
- Smoking (+)
- 15Y ago: BMS (4.0x25mm) dt UA
- BMS ISR Type III



# Pre-PCI IVUS Findings



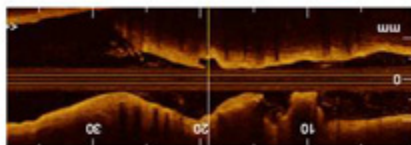
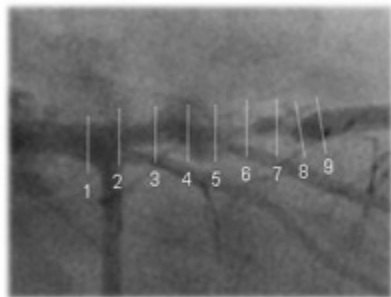
proximal ←



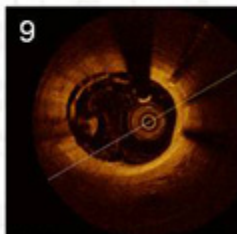
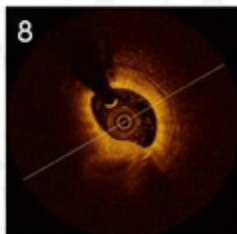
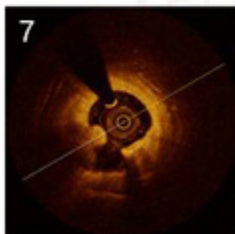
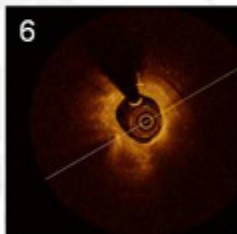
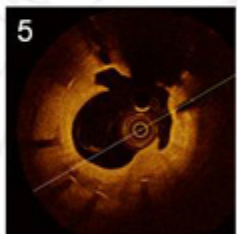
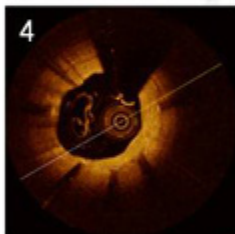
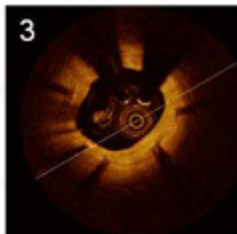
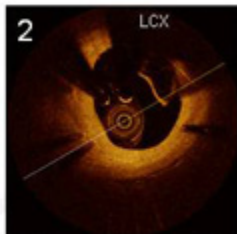
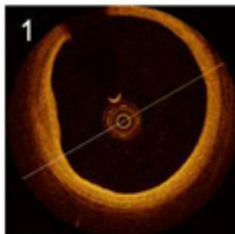
→ distal



# Pre-PCI OCT Findings

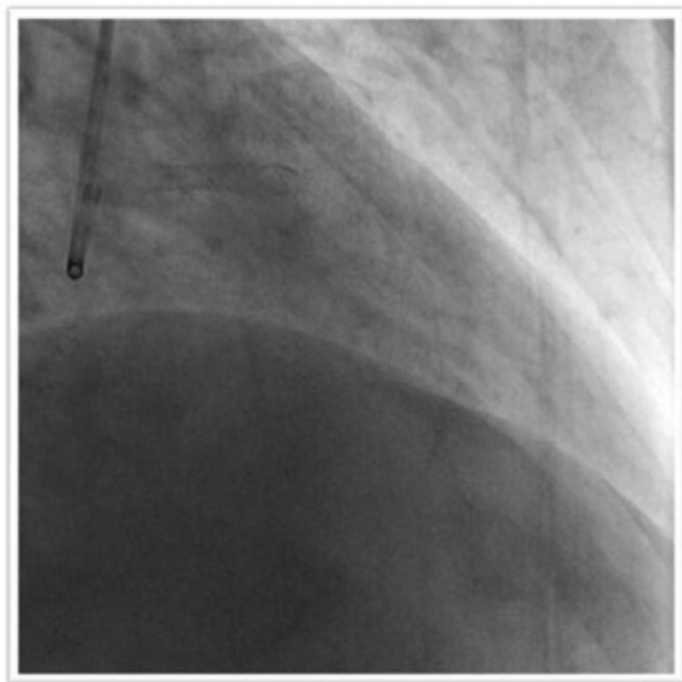
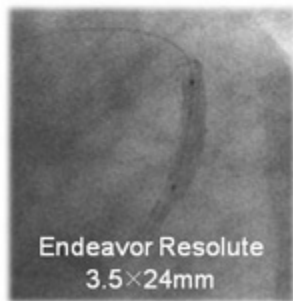
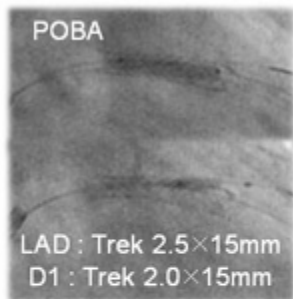


proximal ←



→ distal

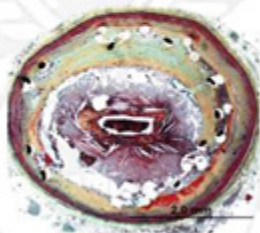
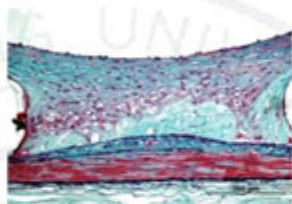
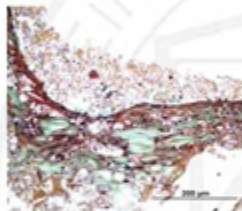
# PCI for DES ISR



Final CAG

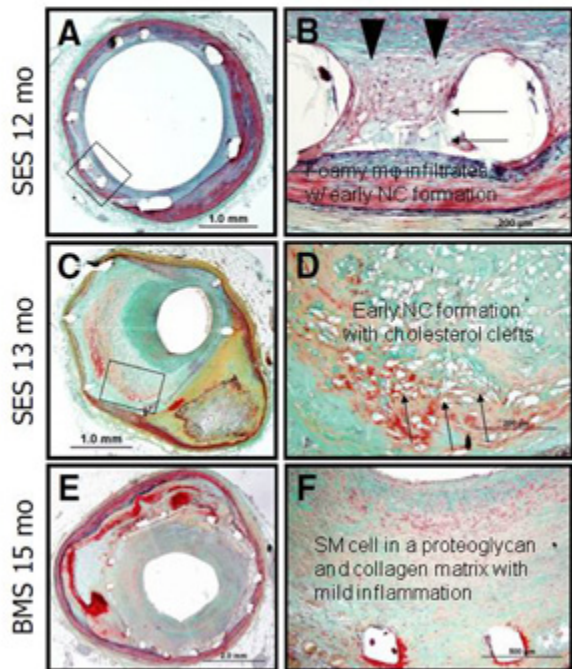
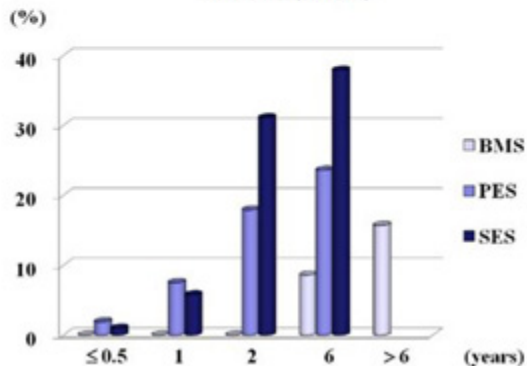
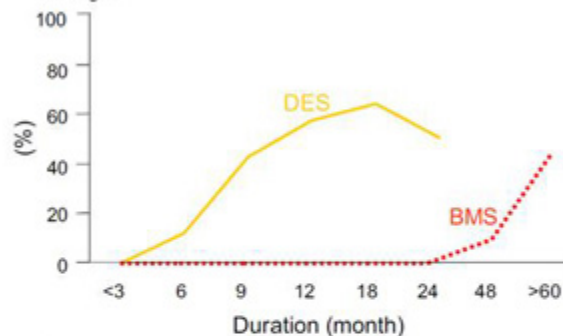
# Histologic Features of Neoatherosclerosis within the Stent

- Peri-stent foamy macrophage clusters with or without calcification
- Fibroatheromas
- Thin-cap fibroatheromas
- Plaque ruptures with thrombosis
- No communication of the lesion within the stent with the underlying native atherosclerotic plaque



# Different Timing of Neoatherosclerosis after BMS vs. DES Implantation

atherosclerotic change

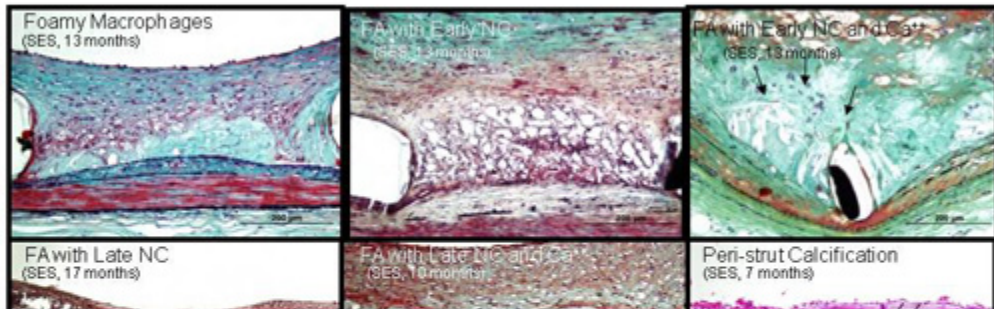


Nakazawa G et al, JACC Img 2009;5:625-628

Nakazawa G et al, JACC 2011;57:1314-1322

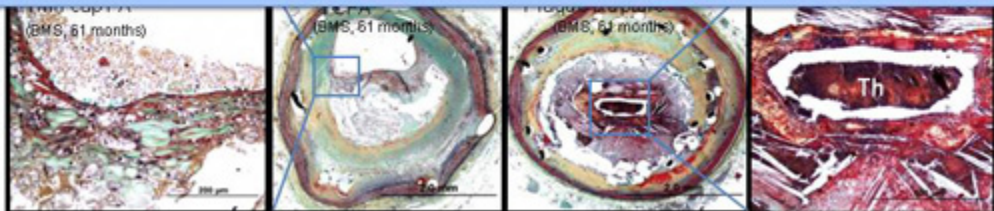
# Pathology of Neoatherosclerosis between DES and BMS

DES



Histopathologic features of neoatherosclerosis are not significantly different between DES and BMS

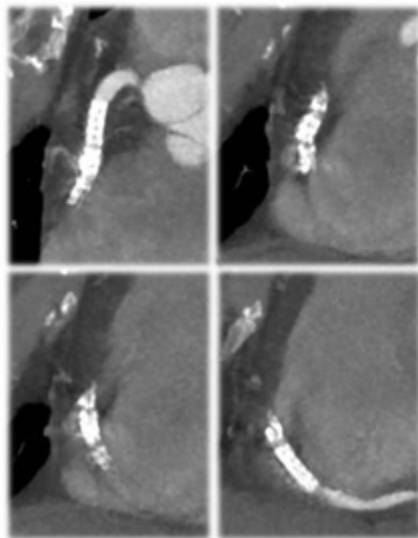
BMS



## Case IV

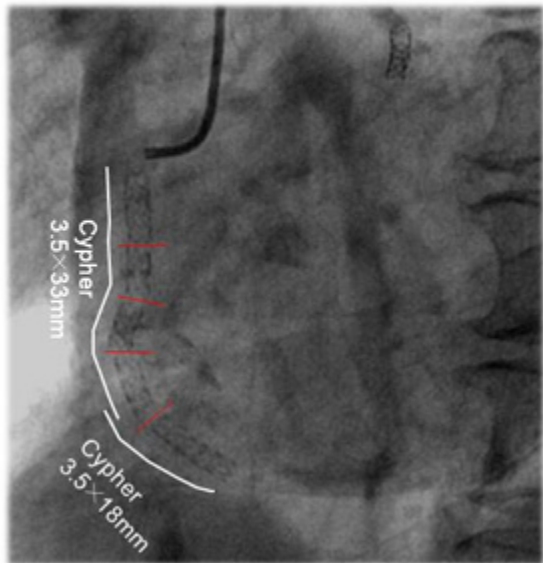
- 69YO / Female
- Unstable Angina
- Smoking (+)
- 6Y ago
  - delayed PCI for STEMI (ant.)
  - \* LAD m: focal disease
    - SES (3.0x18mm)
  - \* RCA p-m: diffuse disease
    - 2 SES (3.5x33, 3.0x18mm)
    - with overlapping
- TTE: severe hypokinesia of LAD territory. EF 42%

### ▪ CT Angiogram

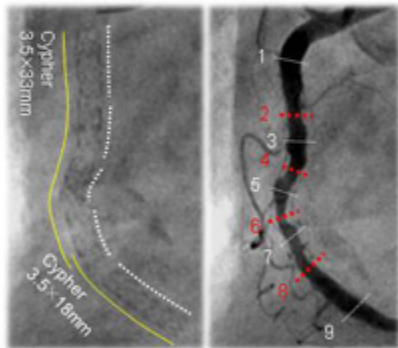


# ACS Presentation @ 6Y FU

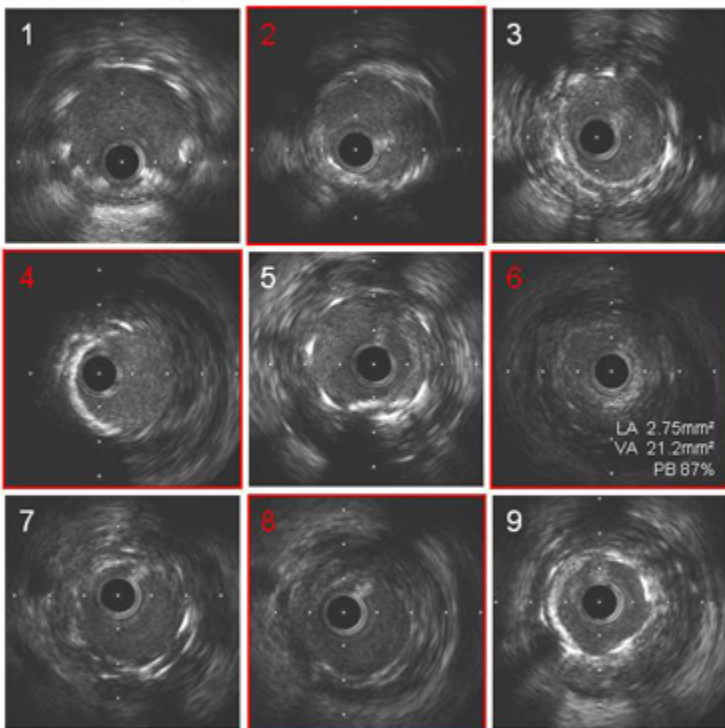
- Multiple stent fractures with DES ISR Type II



# IVUS Findings



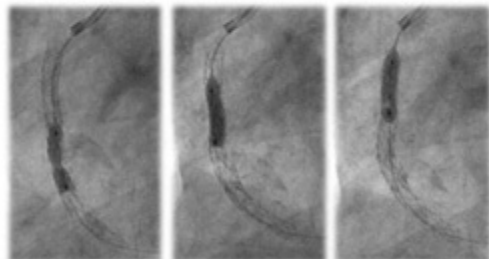
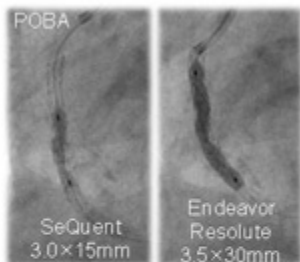
proximal ←



→ distal



# PCI for DES Fractures w/ ISR



NC balloon (3.5mm) inflation

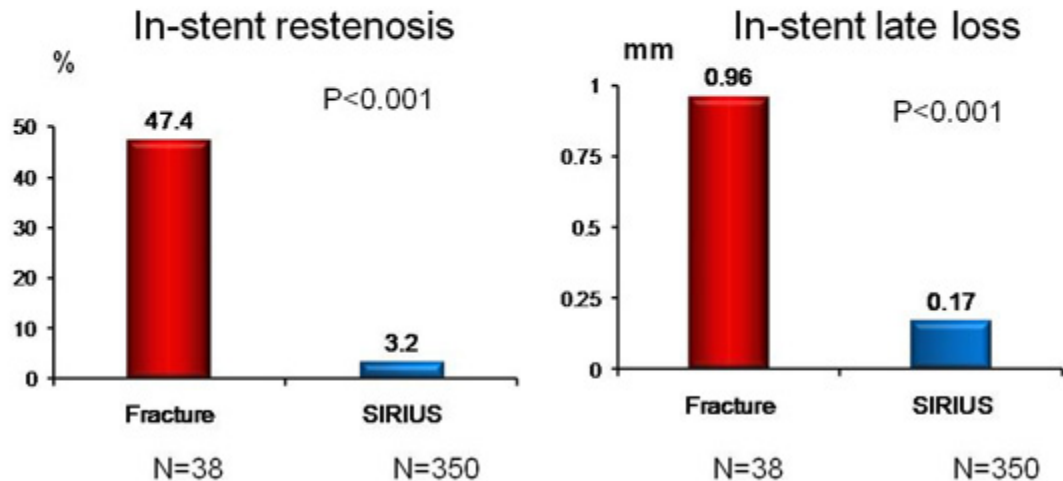


Final CAG

# Stent Fracture Analysis

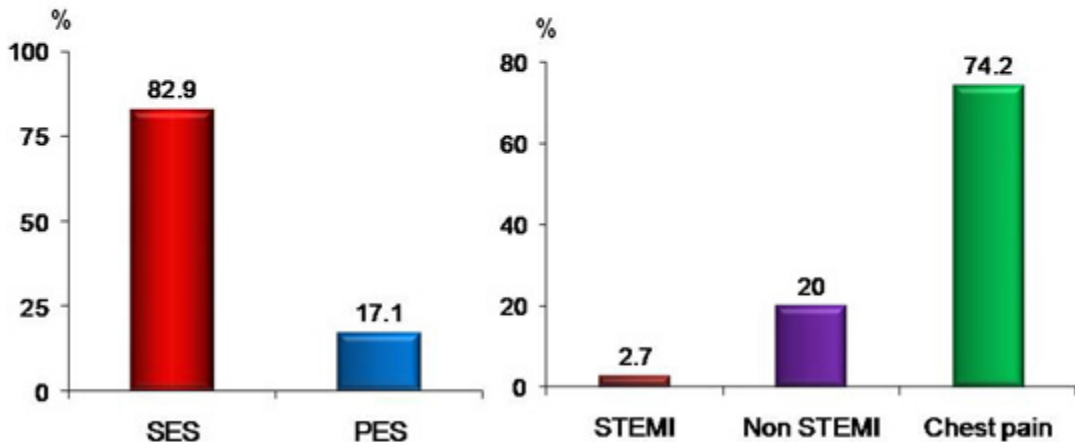
Review of Adverse Event Reports  
submitted to Cordis between August 2003 - July 2006

## Follow-up findings



# Incidence and Clinical Presentation of Stent Fractures

Among 188 pts with DES restenosis, stent fracture was identified in 35 (18.5%) cases



# SUMMARY

## ~ Mechanisms of ISR ~

### Biological Factors

- **intimal hyperplasia**
- hypersensitivity
- drug resistance (DES)
- neoatherosclerosis

### Mechanical Factors

- stent fractures
- non-uniform stent struts distribution
- polymer peeling (DES)
- non-uniform drug deposition (DES)

### Technical Factors

- stent underexpansion
- stent gaps or 'misses'
- barotrauma to unstented segments